

Educational videos on erosion disseminated through social media for soil education

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ABSTRACT: Soil education plays an important role in preventing soil degradation processes by raising awareness among the population about the importance of this non-renewable resource. Using new educational technologies in teaching, such as educational videos and social media, can speed up communication and information. This article aimed to develop educational videos on the topic of erosion, posted on social networks, as a way of popularizing science. Four videos of a maximum of 7 minutes were produced, which were shown in the classroom and on Instagram (@saberessobresolos). In-class promotion reached nine undergraduate and postgraduate classes, totaling an average of 255 students. Metrics used for evaluation were polls and video engagement on the social network. Instagram metrics results indicated, in a period of 49 days, 1615 profiles had accessed the video. There was a reduction in this engagement in other publications, probably due to the variation in time, day of the week, and frequency of posts. The results of the surveys were positive for all the characteristics evaluated, with little disparity among the videos. On a smaller scale, negative feedback was observed, such as: the narration, running time, the translation into Brazilian Sign Language (Libras), and video captions. Approximately 81 % of individuals reported experiencing soil erosion effects, and 59 % had encountered issues as a direct consequence. The evaluation also indicated the videos' ability to enhance knowledge is above 90 %, largely due to the dynamic and inclusive nature of this pedagogical approach, fostering genuine comprehension of the content, satisfaction in learning, and the ability to engage in meaningful discussions on the subject. Disseminating educational videos through social media ensured the democratization and widespread access to soil education, as it expanded reach and facilitated the exchange of knowledge between universities and society. The project fulfills its mission of producing and popularizing knowledge on soils, expanding scientific dissemination, making it more accessible, and contributing to recognizing the importance of conserving this resource.

Keywords: educational videos, social media, social inclusion, educational technology, soil education.

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Received: December 21, 2023

Approved: March 11, 2024

How to cite: Cosmo CFA, Jesus AS, Sales MM, Luz MP, Mascarenha MMA. Educational videos on erosion disseminated through social media for soil education. *Rev Bras Cienc Solo*. 2024;48:e0230166.
<https://doi.org/10.36783/18069657rbc20230166>

Editors: José Miguel Reichert  and Débora de Oliveira .

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INTRODUCTION

Erosional processes are considered natural phenomena, which are involved in relief sculpture dynamics and are caused by agents such as water and wind; however, these processes can be expedited by human actions in the absence of prior planning in land-use-related activities. Accelerated erosion causes damage to the environment and society, such as loss of agricultural productivity, damage to infrastructure, economic losses, and silting of waterways and reservoirs, resulting in floods, water body contamination, and an imbalance of ecosystems (Carvalho et al., 2006).

Soil sealing in urban areas, combined with poor management of drainage systems, facilitates the appearance of linear erosion, especially in tropical regions with a high occurrence of torrential rains (Carvalho et al., 2006), which may deteriorate the quality of life for the population residing in the vicinity of erosional features, representing a common issue in the daily lives of urban dwellers (Jesus and Carvalho, 2017). The damages inflicted upon society range from the accident risks involving the fall of individuals and their vehicles into the erosion, to landslides and road failures, resulting in disruptions to traffic flow and financial losses. However, public authorities respond at a slow pace in controlling erosions and preventing such accidents. Moreover, restoring erosion-affected areas is complex and costly, making prevention the ideal approach (Lopes and Jesus, 2017).

Soil Education can serve as a means through which knowledge on soils becomes accessible, effectively raising awareness among individuals about soil conservation and preventing processes that degrade this non-renewable environmental resource. Students can become transformative agents actively engaged in mitigating impacts, and promote conservation and sustainable use of soil (Muggler et al., 2006). The educator Paulo Freire was one of the pioneers of such teaching practices in Brazil, developing techniques such as transformative education and emancipatory education. Transformative education fosters social transformation by encouraging students' active participation in the learning process, as well as developing critical self-awareness. On the other hand, emancipatory education emphasizes the development of an autonomous mindset and the ability to make decisions considering the problems at hand (Freire, 1984). One of the advantages of this pedagogical approach is the possibility of transmitting and building knowledge in different ways, applicable in both formal and informal education, for example by creating educational materials on the subject, such as books, booklets, games, and educational videos (Muggler et al., 2006, 2020).

Educational videos are a dynamic pedagogical resource that stimulate all the senses by combining visual, auditory, textual and graphic elements. Educational videos are defined as audiovisual communication instruments produced specifically for pedagogical purposes (Gomes, 2008). Integrating audiovisual tools into science teaching offers several benefits as it adds an element of entertainment to the education process and enables adaptation to all types of language. These characteristics facilitate the connection between the topic addressed and the reality experienced by the viewer, ultimately motivating learning and making the dialogue with the audience more assertive (Arroio and Giordan, 2006; Gomes, 2008). Therefore, educational videos focused on soil education can arouse the audience's curiosity and interest in the topic, facilitating awareness and developing a critical sense that can genuinely lead to a change in habits for soil conservation (Muggler et al., 2006; Jesus et al., 2013). Jesus et al. (2013) report that using educational videos with elementary school students proved to be an effective tool in facilitating the topic assimilation. The authors argue that by connecting soil to the lived reality of citizens, they are encouraged to reconsider their relationship with their environment and the importance of this natural resource to themselves, promoting environmental awareness (Jesus et al., 2013). Moreover, the videos enable the demonstration of practical activities in laboratory and field settings for individuals who lack access due to financial constraints

or limitations in their educational institutions' infrastructure (Arroio and Giordan, 2006). Thus, educational videos can be utilized as a supplementary resource for soil education.

In 2015, the Soil Science Society of America created monthly videos teaching about various soil topics (YouTube, 2023). Mendonça and Becker (2024) developed an educational video about slope stability failures to use in basic education and science museum, as well as in graduate and undergraduate courses. The authors verified the video promoted motivational and learning benefits of providing context, establishing relevance, and teaching inductively.

The rapid communication evolution means constantly integrating new information and communication technologies (ICTs) into education. When combined with traditional pedagogical practices, these technologies enable new learning experiences (Leka and Grinkraut, 2014; Araújo and Mussato, 2022). For instance, the internet played a crucial role, especially during the COVID-19 pandemic, shaping new generations that had not previously used it for educational purposes (Gomes, 2021; Araújo and Mussato, 2022). In the 1990s, Lévy (2010), a French philosopher and sociologist, discussed the importance of virtual space for global information connectivity in his studies. Digital networks contribute to the construction of collective intelligence as they serve as dynamic, interactive, and universal communication tools, enabling databases to be accessed by anyone regardless of space and time (Lévy, 2010). There has been a growing use of ICTs, such as media and social networks, for educational, extension, and scientific dissemination purposes. In this context, they can be used as educational technologies contributing to the teaching process (Leka and Grinkraut, 2014; Araújo and Mussato, 2022).

In Brazil, there is a growing trend in the use of social media, which, despite being primarily used for entertainment, is increasingly opening up space for the production and dissemination of educational content (Gomes, 2021). For example, in Geography teaching, Araújo and Mussato (2022) reported Instagram has become a tool to facilitate the communication between teachers and elementary school students, serving as a source of information for research as the social network hosts numerous pages on the topic. Similar results have been found in higher education, where the use of social media has also led to a closer connection between educators and students (Leka and Grinkraut, 2014). In engineering and related fields, some positive reports on the production and dissemination of technical-scientific content through digital platforms or social media can be observed in the studies published by Lima et al. (2019), Silva et al. (2019), Gomes et al. (2021), Cipriano et al. (2022) and Rezende et al. (2023).

Brazilian Society of Soil Science (SBCS in Portuguese) has also been making efforts to use social networks for scientific dissemination purposes (Gomes, 2021), having more than 16 thousand followers on Instagram (accessed on September 8, 2023). Publications on its social media range from general information about soil science to research dissemination, congresses and publications in the Brazilian Journal of Soil Science. The SBCS also created the "National Database of Soil Education Initiatives," which includes all soil education actions and spaces registered in Brazil in a catalog (Muggler et al., 2020). Of the 78 initiatives cataloged in 2020 (Muggler et al., 2020), 35 deal with scientific dissemination on soils using Instagram profiles (Gomes, 2021). In addition, 28 projects also used educational videos among their activities, 12 of which were also associated with a promotional profile on Instagram (Muggler et al., 2020). Among these initiatives is the outreach project called *Multiplicando Saberes Sobre Solos* (Multiplying Knowledge on Soils), developed at the Institute of Socio-Environmental Studies (IESA) at UFG, which provides educational videos on its Instagram profile. This project aims to promote education and popularization of knowledge on soils through accessible materials for use in formal and informal education. Some experiences of these actions can be seen in Mascarenha et al. (2018, 2021, 2024).

This study aimed to develop four educational videos disseminated through social media, focused on soil education, specifically addressing the topic of erosion, as a means of popularizing science. This study also aimed to assess the videos engagement and reach on social media and its didactic suitability for different types of spectators.

MATERIALS AND METHODS

The methodological stages of this research were divided into three stages, namely video production, dissemination and evaluation, as detailed in figure 1.

Video production

The content was covered in four educational videos, subdividing the subject of soil erosion into four topics, namely: [1] Types and concepts, lasting 4 min and 40 s (Instagram, 2023a); [2] Causes and consequences, 6 min and 36 s (Instagram, 2023b); [3] Diagnosis, 5 min and 2 s (Instagram, 2023c); and [4] Prevention and control, 7 min and 7 s (Instagram, 2023d). Shorter videos were chosen as a strategy to capture the viewer’s attention and interest. Furthermore, the content may not be fully comprehended due to the large amount of information presented in long videos (Jesus et al., 2013). The preparation of these videos was carried out in two stages, scripting and editing, because, according to Jesus et al. (2013), it is important there is a scripting stage before producing the educational video so that there is meticulous planning of the pedagogical elements.

Several self-evaluations took place throughout the video production process, where the authors themselves periodically reviewed the material produced in the scripting and editing phases. Self-assessment occurred during team meetings, when the teaching quality and adequacy were discussed, and corrections were made to the scripts and videos if needed. A self-evaluation of the results obtained during the dissemination and evaluation stages by spectators was also carried out.

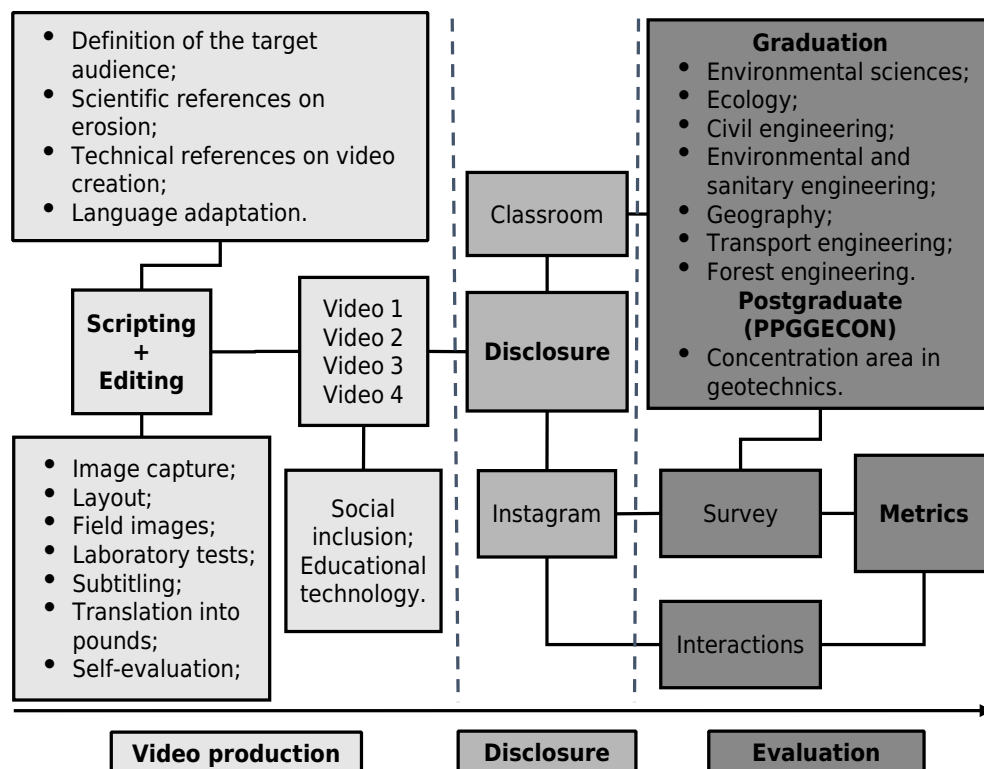


Figure 1. Organizational chart with a timeline of the project’s methodological stages.

Scripting

The script was developed considering the standard content subdivision established within the erosion topic. An extensive bibliographic survey was conducted for each content segment to support the script based on scientific principles. Topics covered in the videos were pre-defined to cover as much content regarding soil erosion as found in the literature, following a logical order that facilitated understanding. Video 1 introduces soil formation and addresses the concepts necessary to understand the topic of erosion, its main types of occurrence and erosive features (Carvalho et al., 2006, 2009). Therefore, the focus is on wind, glacial, and laminar and linear hydraulic erosion (rills, gullies, and gorges). Video 2 presents some of the main causes of accelerated (anthropogenic) erosion, as well as the various undesirable consequences, addressed both in the environmental and socioeconomic context, focusing on the need for soil conservation (Carvalho et al., 2006, 2009; Jesus and Carvalho, 2017; Lopes and Jesus, 2017; Pennock, 2019). Video 3 describes the main techniques used to diagnose erosion, such as mapping and geotechnical erodibility tests, both in the field and in the laboratory (Carvalho et al., 2006, 2009; Mendes et al., 2021; Oliveira et al., 2021; Schlieve et al., 2021). Finally, in video 4, the topic presents some forms of erosion prevention, such as terracing, direct planting, adequate management of livestock and pastures, drainage systems, infiltration systems and environmental education. Furthermore, the main forms of erosion control are presented, starting with drainage, then slope stabilization and, if necessary, damming and backfilling (Carvalho et al., 2006, 2009; Passos et al., 2018; Pennock, 2019; Luz et al., 2021).

The script was adapted from technical-scientific language to more accessible language for the target audience, i.e., more “popular” language. Therefore, whenever possible, technical terms were replaced with general knowledge terms. Moreover, the script for each video was revised and corrected before the material was edited.

Editing

Editing stages involved capturing images, sequencing images, layout, creating captions and translating them into Brazilian Sign Language. Capturing images and layout are important, as the visual elements always need to be in synchronization with the video narration (Jesus et al., 2013). The images were taken from free image banks (Canva, Pixnio, Pixabay, Wikimedia and Pxhere); bibliographical references were adequately cited to credit the authors and the authors’ personal collection. To complement the images, aerial images of the gully in the São João neighborhood, in the municipality of Anápolis (Goiás State), were inserted, where an unmanned aerial vehicle (UAV) was used.

After capturing the images, they were sequenced and edited using the Canva for Education program, which offers a free license for students at federal universities. In this program, musical backgrounds, and audio narration can be inserted. The narration was done using the Microsoft Voice Gallery service, which also has a free license for students. This feature offers different types of speakers and allows users to control the speed, timbre, pronunciation, and other audio settings.

Among the accessibility resources available for educational videos, captions, translation and interpretation into Brazilian Sign Language were used, enabling audiences who are deaf or have impaired hearing access the educational content (Koehler and Nascimento, 2019). Inclusion of these resources in educational materials is mandated by the Brazilian Law for Disability Inclusion, guaranteeing the right to access education for various audiences (Brasil, 2015).

Brazilian Sign Language interpretation window was introduced in the educational videos following the specific regulations for using this resource (ABNT, 2005, 2015). Therefore, the translation was inserted in the lower right corner of the screen, in a visible size and

with good contrast with the background elements (Figure 2). Two trained interpreters participated in the project for the translation and interpretation into Brazilian Sign Language, both with experience in educational videos. Captions in Portuguese were also added, following the NBR 15290 (ABNT, 2005) standards, which establish the requirements for creating captions and transcriptions for the hearing impaired in videos and films. Therefore, the caption was inserted in the lower corner of the screen, using sans serif fonts (DM Sans), size 28, in white, and on a black caption background, ensuring excellent contrast and legibility (ABNT, 2005).

Disclosure

The educational videos were disseminated in two environments: in the classroom and on the social network (Instagram). Educational materials were also made available for external access in schools, at events organized by UFG or outside the university, and in other segments of society.

Classroom

Regarding in-class promotion, subjects were listed within the undergraduate and postgraduate courses at UFG that contained content related to the topic of soil erosion. A total of nine classes were reached, eight undergraduate classes and one postgraduate. Considering undergraduate classes have an average of 30 students and postgraduate classes have an average of 15 (INEP, 2022), the scope for formal education is 255 students.

Among the UFG undergraduate courses that had in-class promotion were: Land Reclamation from the Environmental Sciences and Ecology courses; Soil Science from the Ecology course; and an Introduction to Geotechnics and Soil Mechanics I course from the Civil Engineering and Environmental and Sanitary Engineering courses. In-class promotion also reached beyond the confines of UFG, involving the participation of the Road Construction course in the Transportation Engineering program at the Federal Institute of Goiás (IFG). Engineering Geology course, taught within the Postgraduate Program in Geotechnics,



Figure 2. Cover image of video 2 exemplifying the video layout pattern used in the series. The video title translation is: "Soil erosion: causes and consequences".

Structures, and Civil Construction (PPGGECON) at UFG, was the sole postgraduate course included in the in-class promotion.

Professors accessed the videos through Instagram posts as a strategy to increase engagement on the social network. Professors were instructed to use educational videos as a complement to their classes. They could either show them before or after they spoke. Jesus et al. (2013) argue that the more stimuli on the same content, the easier it is to learn. Furthermore, the authors suggest that showing educational videos before the professor's presentation helps to activate cognitive images about the content covered. Students were also advised to apply surveys to evaluate the videos after they were shown, preferably in the form of an academic activity, to encourage them to participate in this activity.

Social networks

To expand the reach of dissemination and break down physical and social barriers, all the videos produced were posted on Instagram, the fourth most used social network in Brazil, with around 57 million users (Gomes, 2021). The material was made available with free access on the project profile called *Multiplicando Saberes Sobre Solos* (@saberessobresolos), with around 1400 followers (accessed on: April 14, 2023). The videos were published as reels, which ensures greater reach, as the format in which the content is posted (Feed, Reels or Stories) can influence the frequency with which it appears to users (Instagram, 2021).

A total of five posts were made, as video 2 accidentally ended up being posted without translating into Brazilian Sign Language. Therefore, it was decided to publish the translated version of video 2 after posting the whole series, keeping the first post, so that the results could be compared separately. These publications occurred on different dates, between April 14 and May 16, 2023, at different times and days of the week, as shown in table 1. As a result, the duration of the post, until the metrics were collected, and the intervals between publications varied between videos (Table 1).

To increase engagement with the videos and encourage the public to answer the polls, a carousel post was made after the videos were posted. The post announced the series on soil erosion was complete and directed users to the poll link in the profile biography.

As video 1 was produced previously, it ended up having more time to be publicized and pre-posted on Instagram. Between April 29th and August 22nd, 2022, the video reached 1198 accounts; it had 454 view counts and 97 interactions with the content.

Evaluation

Although there is no consensus on which criteria to use to evaluate educational videos, the material quality must be valued to ensure the pedagogical objectives were achieved

Table 1. Information about Instagram educational video posts during the dissemination period

Video	Title	Date	Day of week	Time	Interval	Duration
				hours	days	weeks
1	Types and Concepts	04/14/2023	Friday	15	NA ⁽¹⁾	6
2	Causes and Consequences	04/18/2023	Tuesday	14	4	5
3	Diagnosis	04/19/2023	Wednesday	17	1	5
4	Prevention and Control	04/23/2023	Sunday	11	4	4
2	Causes and Consequences ⁽²⁾	05/16/2023	Tuesday	19	23	2

⁽¹⁾ NA: Does not apply; ⁽²⁾ Repost: Second post of video 2 (into Brazilian Sign Language).

(Gomes, 2008). Therefore, to qualify the educational videos on soil erosion, some analysis criteria were defined, based on references on assessment of the educational videos' quality, with adaptations to the project context (Gomes, 2008; Jesus et al., 2013). Four standardized surveys were used to individually evaluate the videos, using Google Forms links, to be completed anonymously by any participant. Evaluation was focused on the public's perception of the technical content presented, the video aesthetics, and the accessible language, as recommended by Gomes (2008).

The questionnaire was divided into some groups of questions, starting with the viewer's personal information, namely: age group; gender identity; level of education; undergraduate course (if applicable); and the state in which they reside. The audience profile could be traced using this data during the marketing campaign.

Afterwards, questions involving their own experiences related to the topic of soil erosion, such as: "Is there soil erosion in the region where you live?", "Have you or someone you know ever had a problem caused by soil erosion?", "Do you think it is important to prevent soil erosion?", and "Do you know any techniques for preventing soil erosion?". There were the options of "Yes", "No" or "Probably" as an answer to all the questions.

In the following questions, participants had to assign a rating on a scale of 1 to 5 (in which 1 is very poor and 5 is very good) according to their perception of the quality of the following video aspects: editing, images, aesthetics, narration, content, running time, language adaptation, translation into Brazilian sign language and textual caption.

Finally, the questions that evaluate the video's ability to add knowledge are: "How enjoyable do you think this video was to watch?", "How likely are you to recommend this video to someone?", "How well were you able to understand the content covered in the video?", "How much did you know about the content covered in the video?", "How much do you think this video helped to enhance your knowledge about soils?", and "How much do you think this video helped to enhance your knowledge about soil erosion?"

In addition to the evaluation with the surveys, meetings of the PPGGECON Erosion Research Group, comprising lecturers, undergraduate and postgraduate students from UFG, are included. The project was presented to the PPGGECON Erosion Research Group during the pre-disclosure, when the results produced were presented. Participants evaluated video 1 by answering an exclusive survey, which, combined with suggestions made in the meeting, helped to improve several aspects of the following videos. Among the adjustments are increasing the font size, images, and the translation window, as well as reducing the speed of the video narration.

To evaluate the results obtained on Instagram, the metrics achieved by the posted videos were used. Success of the video promotion on the social media platform can be observed through the engagement of the posts, which includes number of interactions with the content, profiles reached, and video views (Instagram, 2023e).






RESULTS AND DISCUSSION

Results were analyzed based on the metrics achieved by the videos on the social media platform and the responses obtained from the surveys. Collected data pertain to a 49-day period of dissemination, occurring between April 14 and June 2, 2023.

Engagement on media

Instagram metrics reveal that all videos generally had large interaction and view counts in a short time (Table 2). Among the interactions, the number of saves is worth highlighting, as it demonstrates the public interest in revisiting the educational material. The reached accounts reflect the number of people who encountered the material, divided between

Table 2. Engagement results of the educational videos posted on Instagram @saberessobresolos

Video						Accounts reached		
	Plays	Likes	Comments	Shares	Saves	Followers	Non-followers	Total
Types and Concepts	1980	120	9	52	14	430	1185	1615
Causes and Consequences	894	71	3	10	6	320	431	751
Diagnosis	521	47	2	14	4	287	149	436
Prevention and Control	798	55	1	5	9	370	235	605
Causes and Consequences ⁽¹⁾	974	65	6	5	8	435	414	849

⁽¹⁾ Repost: Second publication of video 2 (into Brazilian Sign Language).

those who are already followers of the page and non-followers. The number of non-followers is quite significant since most followers already have a certain level of knowledge in soils due to their institutional affiliation. Thus, the large number of non-followers may indicate that one of the project's objectives, to extend beyond the university sphere and reach the general society, has been achieved.

Video 1 was the post with the highest number of interactions and reached accounts (Table 2). When compared to in-class promotion, the number of individuals who engaged with the material through the social media platform with just the first video (1615 accounts) is equivalent to 54 classes with an average of 30 students each. In the subsequent posts, there was a noticeable decline in engagement, although the reach achieved would be challenging to attain solely through in-class promotion. In other words, social media can be an effective means of scientific dissemination about soils, facilitating communication and collaboration among people worldwide (Leka and Grinkraut, 2014; Gomes, 2021; Araújo and Mussato, 2022).

The drop in engagement is not necessarily linked to material quality but may be related to factors intrinsic to social networks and internal dissemination. Regarding internal dissemination, the team made more effort to share video 1. This was because it was expected the calls at the end of the videos themselves, combined with the information that video 1 was part of a series, would be sufficient to encourage the public to follow all the videos. However, the results indicate that dissemination strategies must be reinforced for each new video posted, even if it is part of the same series.

Regarding the social media platform, the reach results are connected to Instagram's communication technologies. There are dozens of algorithms that influence the content shown to users based on their interests (Instagram, 2021, 2023e). Thus, the reach of the posted content can be affected by each individual's preferences, identified by the system through their interactions with other profiles and posts (Instagram, 2021).

Variations in engagement can also be related among the videos with the times they were posted, the day of the week, and even the intervals between posts (Table 1). These variables are highly relevant for professional and sales profiles as they promote products and brands. Therefore, most digital marketing studies are oriented towards these sectors. It is common for these pages to adopt marketing strategies to reach more consumers, which vary depending on the type of product and target audience. Ideally, a more in-depth understanding of digital marketing and social media analytics and tailored scheduling based on individual results would be beneficial. Instagram social media analytics involve data collection and performance metrics for posts and accounts (Barnhart, 2023).

According to studies released by the Sprout website, in general, the days and times with the highest engagement for educational profiles are Tuesdays, Wednesdays and Thursdays between 10 am and 4 pm (Keutelian, 2023). The video with the highest reach was posted on a day and time not recommended, indicating that other factors influence this reach.

The engagement increased when the interval between posts increased (Tables 1 and 2). The second post of video 2 (into Brazilian Sign Language) obtained better results than the first publication, despite the content being repeated. The interval between these posts was four days (between video 1 and video 2) and 23 days (between video 4 and translated video 2), indicating that the ideal would be to increase the interval between posts. However, Sprout disclosed that the ideal posting frequency is one to two times a day (Hill, 2022), contrary to the results obtained.

On the other hand, the running time of the promotion did not affect engagement, as the second release of Video 2 had more view counts than the initial release, despite having a shorter promotion period.

Survey

Four standardized surveys were provided for audience evaluation to evaluate the quality of each educational video separately. However, this approach proved to be less advantageous as the number of participants varied across the surveys, following a trend of evasion, with 87 responses for Video 1 decreasing to 59 for Video 4. This suggests a loss of interest among the audience, possibly due to repetitive questions. Therefore, in future projects, administering a single questionnaire to evaluate all the videos is recommended.

Results obtained from the surveys did not show significant disparities. Thus, the average of the results will be presented for all questionnaire groups, except for the one intended to evaluate the quality of the videos; this will be analyzed individually for each video.

Viewers' profiles

Some personal information was requested to analyze the viewers' profiles, and the results can be observed in table 3. Regarding age, most participants are between 16 and 29 years old (89.5 %), a demographic that corresponds to the university audience. Results related to education indicate that the vast majority are undergraduate and postgraduate university students (88 %). This suggests the survey participants are primarily students from the courses where the promotion and academic activities took place, rather than social media audiences. There was also significant participation from the Basic Education to Technical Education audience (10.5 %), who likely used the educational material for personal learning purposes. In turn, the audience at levels higher than Specialization courses (2 %) may have used the videos for teaching purposes.

Participants who had a higher education level were also asked to provide information on their field of study. Results reveal that the highest participation was from the Environmental Engineering course (39 %), followed by the Civil Engineering courses (25 %), Ecology (15.5 %) and Environmental Sciences (9.5 %). These courses match the pre-selected classes for in-class promotion and reinforce this profile made up practically of local university students. However, the participation of students from other courses that were not part of the internal promotion (10.5 %), such as Agronomy, Biotechnology, Physical Education, Forestry Engineering, Geography (Bachelor and Bachelor of Education degrees) and Geoprocessing, is noteworthy. This indicates that people are searching for information through Instagram.

Results regarding the participant's gender reveal a predominance of females (56 %), compared to males (41 %). To explain this greater female public representation, these results should be related to those obtained in the previous topic. In engineering, in general,

Table 3. Results obtained from the educational video surveys, referring to the participants' personal information

Information	Video				Average
	1	2	3	4	
	%				
Age					
0 - 15	1	0	0	0	0
16 - 29	85	89	90	90	89.5
30 - 40	14	11	10	10	10.5
Education					
IF - CT ⁽¹⁾	8	11	14	10	10.5
IHE - CE ⁽²⁾	89	88	84	88	88
IM - CD ⁽³⁾	3	2	2	2	2
Course					
Environmental Sciences	9	9	10	10	9.5
Ecology	21	14	13	17	15.5
Environmental Engineering	39	41	38	39	39
Civil Engineering	18	25	29	25	25
Others ⁽⁴⁾	13	11	10	9	10.5
Gender					
Feminine	57	55	55	58	56
Masculine	40	42	42	38	41
NA ⁽⁵⁾	3	3	3	4	3
State					
GO ⁽⁶⁾	98	98	98	98	98
DF ⁽⁷⁾	1	2	2	1	1.5
PA ⁽⁸⁾	1	0	0	0	0
PB ⁽⁹⁾	0	0	0	1	0

⁽¹⁾IF - CT: Incomplete Fundamental to Complete Technical; ⁽²⁾IHE - CS: Incomplete Higher Education to Complete Specialization; ⁽³⁾IM - CD: Incomplete Master's to Complete Doctorate. ⁽⁴⁾Others: Agronomy, Biotechnology, Physical Education, Forestry Engineering, Transportation Engineering, Geography, Geoprocessing; ⁽⁵⁾NA: None of the alternatives; ⁽⁶⁾GO: Goiás; ⁽⁷⁾DF: Federal District; ⁽⁸⁾PA: Pará; ⁽⁹⁾PB: Paraíba.

there is a predominance of male students, who, in 2010, represented 71.2 % of students (INEP, 2022). In 2021, the percentage of women grew, reaching 43.6 % of students. However, the course with the highest participation in the surveys was Environmental Engineering (Table 2), which had 68.1 % of women enrolled in the same year. The second course with the highest participation was Civil Engineering, where women represented 47.5 % of students enrolled in the same survey. However, there was participation from areas other than engineering, due to the multidisciplinary nature of the erosion topic. Therefore, the results indicate that this approach makes room for gender diversity.

Regarding the viewers' state of origin, on average 98 % of the people were from the state of Goiás. States of Pará, Paraíba and the Federal District correspond to the origin of the remaining 2 % of the audience. Thus, the promotion also transcended geographical barriers, albeit to a lesser extent, due to the reach provided by the social media platform.

Public-thematic relationship

The following questions deal with the audience's relationship with soil erosion. To estimate how widespread the presence of erosion is in the audience's daily lives, the question was "Is there soil erosion in the region where you live?", the results are presented in figure 3a and indicate the vast majority of the audience (on average 81 %) lives close

to erosive features. When interviewing residents surrounding gullies in the urban area of Anápolis (Goiás), Jesus and Carvalho (2017) revealed that this proximity affects the life and health quality and poses a risk to residents' lives. According to the authors, erosion is associated with low education, underemployment, low wages and poor urban infrastructure, in addition to socioeconomic losses caused by damage to buildings. In this context, due to society's broad relationship with erosion and the socioeconomic consequences it brings, the need to disseminate knowledge in formal and informal education is reinforced, focusing on adopting preventive practices regarding erosion (Muggler et al., 2006; Jesus et al., 2013; Jesus and Carvalho, 2017).

To obtain estimates of the extent of the problem caused by erosion processes, the question was "Have you or someone you know ever had a problem caused by soil erosion?" (Figure 3b). Once again, the largest percentage of the audience (59 %) has already encountered a problem caused by erosion. Among the most reported problems in the city of Goiânia associated with erosion are accident risks, damage to trafficability and road failures (Lopes and Jesus, 2017). The risks also involve an increase in the frequency of natural disasters caused by land-use changes, rivers silting, waterproofing, and lack of adequate drainage (Jesus and Carvalho, 2017; Lopes and Jesus, 2017). Among the associated natural disasters are landslides, which, between 1988 and June 2022, killed 4,146 people in Brazil (Macedo and Sandre, 2022). Other examples are floods and inundations; together these disasters left 6.4 million people dead, homeless or displaced in the country in eighteen years (Folha de São Paulo, 2018). From this perspective, it is clear that erosion processes must be urgently debated and the authorities must take measures to mitigate and control this problem.

The question "Do you think it is important to prevent soil erosion?" was the only one that obtained a unanimous result in which 100 % of people answered "Yes" in all polls. This is probably due to the intuitive nature of the question, combined with the information previously presented in the educational videos.

In the question "Do you know any techniques for preventing soil erosion?", 89 % of people answered "Yes" while 11 % answered "No". This can be related to the percentage obtained for the level of education, which indicated a profile comprising most university students (Table 2). These students certainly acquired prior knowledge about prevention techniques in their courses, which indicates this topic is relevant in their fields of study. Certainly, the results would be different if dissemination in formal education were expanded to other areas of knowledge that do not have this topic in their syllabus. It would be interesting if this question was associated with a question that indicated whether viewers had learned

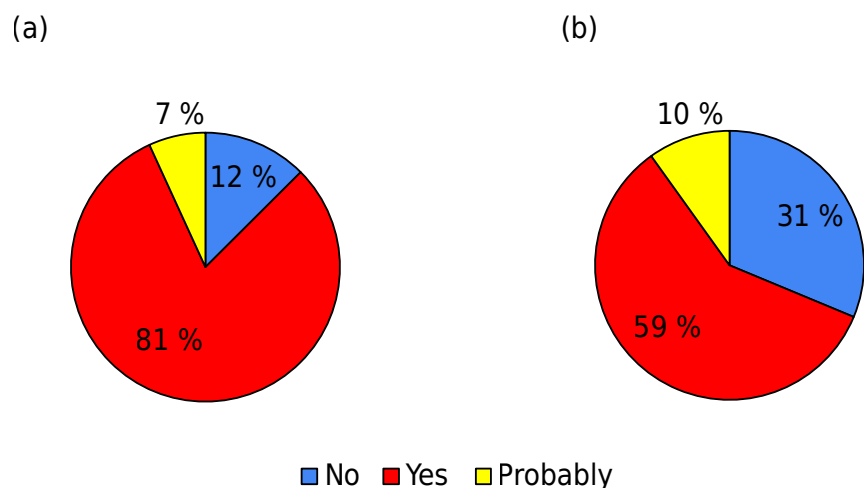


Figure 3. Public relationship with the topic of erosion: (a) Presence of erosion in the region where people live; (b) Report of problem associated with erosion.

any new techniques for preventing erosion, however, this shortcoming was only noticed after data collection.

Quality of the video

Figure 4 presents the results regarding the quality of the videos separately to observe whether there was a change in the viewers' vision among the videos. In general, all characteristics were evaluated positively, and there was not much disparity among the videos, as can be seen in figure 4. The best-evaluated aspects were, respectively, the content covered, adequacy of language, images, editing and video aesthetics. However, even in a smaller percentage, there was some negative feedback on certain aspects that need to be explored, namely: narration, running time, translation into Brazilian Sign Language and captions. This feedback is necessary to continuously improve the material, in addition to support during the production of future educational videos (Arroio and Giordan, 2006; Gomes, 2008).

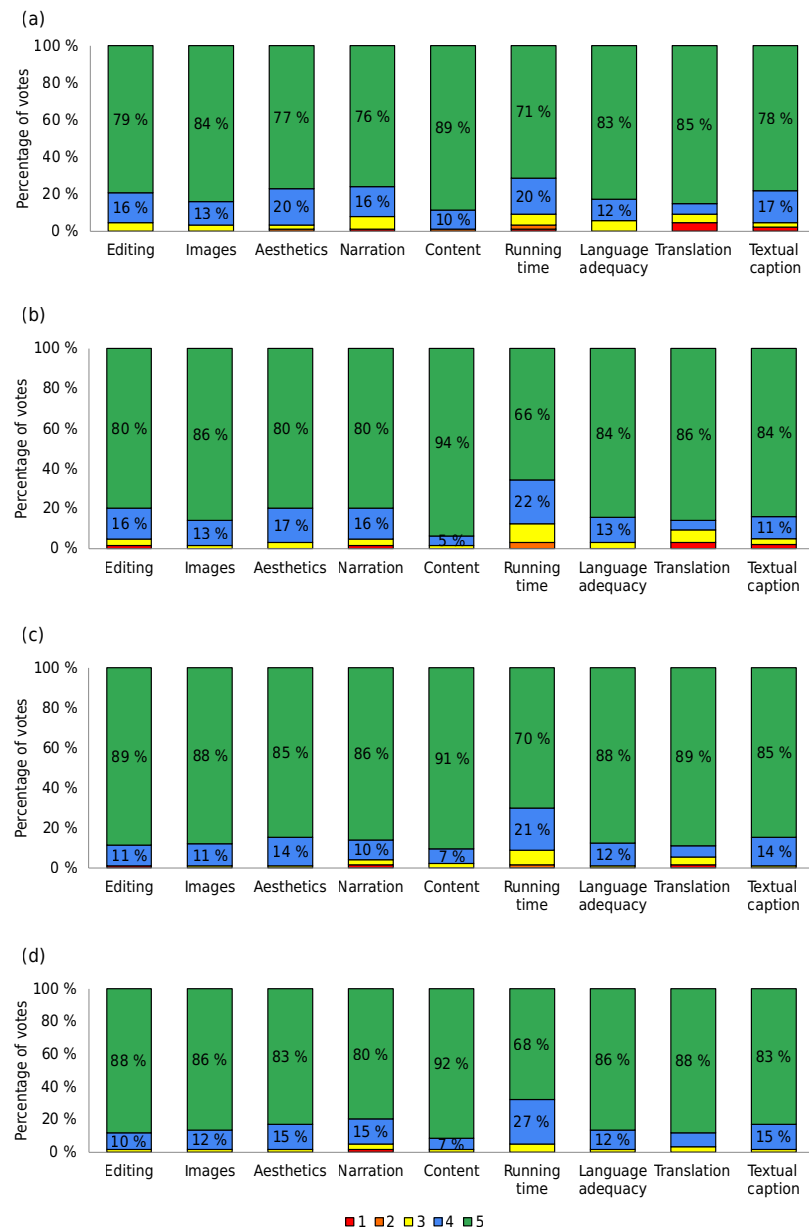


Figure 4. Results obtained from the evaluation regarding the quality of the characteristics of the educational videos: (a) Video 1; (b) Video 2; (c) Video 3; (d) Video 4. On this scale, a rating of 1 corresponds to very poor, and 5 corresponds to very good.

The running time of the video is the characteristic with the most negative feedback in all the videos (Figure 4). Digital technology has accelerated the speed of communication and information, leading to an increasingly impatient society (Lévy, 2010). Social media platforms such as TikTok, Facebook, YouTube, and Instagram may also be influencing the younger generations to be more impatient (Gomes, 2021), fostering a culture that favors increasingly quick content. Thus, the obtained results may be a reflection of the current generation, which tends to prefer shorter videos, influenced by the virtual environment.

It is worth discussing whether making the videos shorter to cater to this audience is compensatory. Given the extensive knowledge available on the subject, reducing the duration could imply a loss of content quality. During the scripting phase, the content was already simplified to the maximum, and further condensing it might lead to a deviation from the project's objectives. An alternative could be breaking down the content into more specific topics, shortening the video running time but resulting in a longer series. Thus, instead of reducing the content, the more advantageous solution would be to make the content more engaging through other pedagogical strategies that need to be considered.

Didactic adaptation can often be a challenge, especially when converting knowledge from a technical-scientific language to a more popular one. Gomes (2008) argues that most educational videos use language closer to that of a book or magazine, resulting in a lack of interest from students. Furthermore, the more educational content aligns with the students' lived reality, the more it captures their attention (Muggler et al., 2006; Gomes, 2008).

Video narration received some negative feedback. It was better evaluated in Videos 1 and 2 (Figures 4a and 4b) compared to Videos 3 and 4 (Figures 4c and 4d). After the pre-release and self-assessment of Video 1, the narration speed was reduced in the subsequent videos to improve comprehension and content assimilation. This reduction in narration speed led to an increase in the videos' running times. This would explain the results, as the current trend is to prefer faster and more assertive communication (Lévy, 2010). In addition to the increased duration, the voice service used for off-screen narration simulates the human voice but has limitations in intonation and pronunciation that result in a loss of naturalness. This noticeable speech automation may have led to a disconnection between the viewer and the narrator, creating a certain awkwardness. Thus, this negative feedback can also be attributed to people who prefer original narrations compared to those created by computer programs.

Accessibility is one of project principles, introduced in the educational material through captions in Portuguese and the translation and interpretation window for Brazilian Sign Language, catering to the audience with deafness or hearing impairment (ABNT, 2015; Brasil, 2015). However, accessibility features were not used during the dissemination and evaluation phases, which did not provide an estimate of participants with hearing disabilities. The lack of this information makes it challenging to understand why the sign language translation did not please everyone. It can be assumed that, due to societal prejudices, the reason might be the "visual pollution" for people who do not need this resource. For participants with disabilities, the reasons could be related to the resources' quality, such as the size of the caption or translation window, which did not ensure good visibility or even the quality of the translation and interpretation.

There were changes in some translation features starting from Video 2, which may have also influenced the results. These changes include a larger translation window, a shift in the window's position from the upper right corner to the lower right corner, the removal of the frame and background from the translation window (previously framed with a white background), and the replacement of the sign language interpreter with another professional starting from Video 2. However, all hypotheses raised could only be concluded with data collection about the audience in need of accessibility features.

Captions received only negative evaluations in Video 1 (Figure 4a), while the other videos were well-rated in this aspect (Figures 4b, 4c and 4d). In Video 1, a different caption format was chosen (black text on a white background). Starting from Video 2, the format began to follow the standards established in NBR 15290/2005, ensuring better contrast and visibility of the words (ABNT, 2005). Therefore, the result can be attributed to the caption format in Video 1, which likely affected its readability.

Ability to convey knowledge

The purpose of this section in the questionnaire is to analyze whether the produced educational videos were truly able to impart knowledge. Overall, all evaluated aspects achieved very good results, as observed in figure 5. Despite the questions directly addressing the levels of knowledge acquired in both soils and soil erosion, factors that may influence the outcome, such as the viewers' level of prior knowledge, comprehension of the content, satisfaction, and recommendation of the educational material, were analyzed.

The prior knowledge pertains to the viewers' previous personal experiences with the subject matter. Figure 5 shows that more than 70 % of the audience has a very good level of prior knowledge, which is expected for the profile of students active in the field of study. Nevertheless, when comparing these values with the ability to impart knowledge (above 90 %), it is clear the videos were effective in delivering additional content on erosion and soil.

The satisfaction level with the videos was quite high (around 95 %; Figure 5), similar to the number obtained for text comprehension. Satisfaction in teaching is achieved through the closeness between educators and students, creating a more meaningful and challenging learning environment (Paulo Freire, 1996). Satisfaction during the learning process makes students more motivated, creative, and committed to their work and more likely to retain new knowledge (Paulo Freire, 1996). On the other hand, comprehension is the ability to connect new knowledge to the student's prior knowledge and experiences (Freire, 1984, 1996). According to Morin (2014), education should be based on complex thinking and understanding. Paulo Freire considered understanding as an essential part of the learning process as it only materializes if the learner truly understands the subject matter. He states understanding can be achieved through dialogue and reflection on the meaning of this knowledge for their own lives. The author also argues students learn more when discussing and thinking critically about the material.

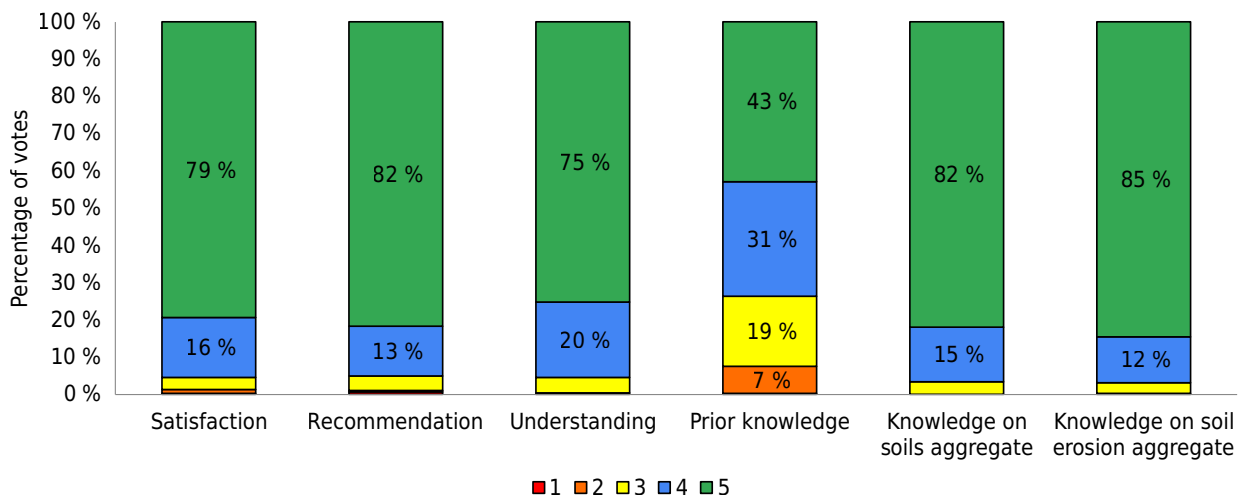


Figure 5. Average results obtained regarding the videos' ability to impact knowledge. On this scale, a rating of 1 corresponds to very poor, and 5 corresponds to very good.

The recommendation level of the videos expresses participants' interest in sharing this knowledge with others. By sharing new knowledge, opportunities for debates arise, which helps to consolidate learning (Freire, 1996; Morin, 2014). Morin (2014) agrees that debate is important for improving learners' understanding because discussing the subject makes the student capable of challenging their own ideas and considering other possibilities. Moreover, the act of sharing educational material makes the viewer a transformative agent and indicates that the pedagogical method adopted was successful in the social transformation process, influencing the individual to apply this new knowledge, whether by sharing it with others or in decision-making (Freire, 1984; Muggler et al., 2006).

CONCLUSIONS

This study resulted in a series of four educational videos on soil education, which were promoted in formal education settings (such as classrooms) and on social media platforms (for informal education), and were posted on Instagram (@saberessobresolos), ensuring free access to educational content for the audience. However, the interaction and view counts varied from one video to another, with the first in the series having the highest reach. There was a reduction in this engagement throughout the posts, likely due to variations in time, day of the week, and posting frequency. Thus, Instagram proved to be a promising educational technology that could expand science's reach and ensure social inclusion in soil education.

The strategy of using this instrument for the individual analysis of each video was not very advantageous, as the number of participants varied, following a trend of attrition. However, through these surveys, the viewers' profiles were created, mainly comprising university students from the state of Goiás. It was also inferred that most participants originated from in-class promotion, from the Environmental Engineering, Civil Engineering, Ecology, and Environmental Sciences courses. Despite engineering being popularly known as being a 'male profession,' there was a higher representation of female participants in the surveys.

Most people deal with erosions and the problems arising from them. Therefore, this is an important issue that deserves greater attention from the public authorities. Regarding aspects directly related to the quality of the educational videos, the results were positive for all evaluated characteristics, with little disparity between the videos. The technical content covered stands out, obtaining the highest percentage of high ratings. On a smaller scale, negative feedback was observed in some aspects, which should be used to continuously improve the produced material and develop future projects, such as narration, running time, Brazilian sign language translation, and video captions.

The running time was the characteristic that least pleased the audience, somewhat affected by the speed of the narration. However, to adapt without losing quality, the most recommended approach is to focus efforts on making the content more attractive through didactic adjustments in illustrations and dividing the content into smaller videos. Regarding the translation and captions of the videos, these accessibility features were incorporated to cater to the audience who was deaf or had hearing impairments. Despite this, the dissemination and the survey were not inclusive. Therefore, efforts need to be directed toward reaching this audience during future promotions.



Educational videos have a significant ability to aggregate knowledge in soils. This is largely due to the dynamic and inclusive nature of this educational approach, which leads to a genuine understanding of the content, satisfaction in learning, and the ability to engage in debates on the subject. Dissemination of educational videos through social media ensured the democratization and broad access to soil education, as it not only expanded the reach but also facilitated the exchange of knowledge between the university and society. The project fulfills its mission to produce and popularize knowledge




in soils, enhancing scientific dissemination, making it more accessible, and contributing to recognizing its importance for the conservation of this resource.



ACKNOWLEDGMENT

The authors express their gratitude to Eletrobras Furnas and the National Electric Energy Agency (ANEEL) for the technical coordination and funding under the Research and Development (R&D) Project entitled 'Modeling at Various Scales of Sediment Generation in Erosions and its Contribution to Reservoirs of Hydropower Plants,' ANEEL R&D Sediments project, ANEEL code PD.0394-1705/2017. The authors are thankful for the funds provided by National Council for Scientific and Technological Development (CNPq), process 302985/2021-2, and for funding the undergraduate research scholarship. Finally, the authors would like to thank the Unmanned Aerial Vehicles Program (PROVANT) of the Image Processing and Geoprocessing Laboratory (LAPIG) at UFG for providing one of its UAVs for capturing aerial images used in the educational videos produced, and the Center for Studies in Hydrology and Geotechnics (CEHIGE) and the Geotechnical Laboratory (LABGEO) of the School of Civil and Environmental Engineering (EECA) at UFG for providing images of laboratory tests.



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REFERENCES

- Araújo WS, Mussato OB. Tecnologias educacionais e redes sociais: O Instagram como recurso didático para o ensino de geografia. *Rev Eletron Casa Makunaima*. 2022;4:5-18. <https://doi.org/10.24979/makunaima.v4i2.1115>
- Arroio A, Giordan M. O vídeo educativo: Aspectos da organização do ensino. *Quim Nova*. 2006;24:8-11.
- Associação Brasileira de Normas Técnicas - ABNT. NBR 15290: Acessibilidade em comunicação na televisão. Rio de Janeiro: ABNT; 2005. Available from: <https://www.cnmmp>.

- mp.br/porta1/images/Comissoes/DireitosFundamentais/Acessibilidade/NBR_15290-2005_Comunica%C3%A7%C3%A3o_TV.pdf.
- Associação Brasileira de Normas Técnicas - ABNT. NBR 15604: Televisão digital terrestre - Receptores. Rio de Janeiro: ABNT; 2015. Available from: http://www.telemidia.puc-rio.br/~rafaeldiniz/public_files/normas/SBTVd/pt_BR/ABNTNBR15604_2007Vc_2008.pdf.
- Barnhart B. Instagram analytics: How to analyze and use your data. Chicago: Sproutsocial; 2023 [cited 2023 Oct 17]. Available from: <https://sproutsocial.com/insights/instagram-analytics/>.
- Brasil. Lei nº 13.146, de 6 de julho de 2015: Institui a lei brasileira de inclusão da pessoa com deficiência (Estatuto da Pessoa com Deficiência). Brasília, DF: Diário Oficial da União; 2015. Available from: https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13146.htm.
- Carvalho JC, Cordão Neto M, Aguiar LA. Livro comemorativo dos vinte anos do Programa de Pós-Graduação em Geotecnia da Universidade de Brasília. Brasília, DF: Editorial FT; 2009.
- Carvalho JC, Sales MM, Souza NM, Melo MTDS. Processos erosivos no centro-oeste brasileiro. Brasília, DF: Finatec; 2006.
- Cipriano JA, Cruz GA, Machado FLO, Carvalho JDGC. Produção de vídeos em projeto de extensão como facilitador do ensino na engenharia de alimentos. In: Anais do Congresso Brasileiro de Educação em Engenharia e V Simpósio Internacional de Educação em Engenharia. Brasília, DF: Abenge; 2022.
- Folha de São Paulo. Desastres naturais deslocaram 6,4 milhões de brasileiros desde 2000. Introdução - Natureza do desastre; 2018 [cited 2023 Oct 9]. Available from: <https://temas.folha.uol.com.br/natureza-do-desastre/introducao/desastres-naturais-deslocam-6-4-milhoes-de-brasileiros-desde-2000.shtml>.
- Freire P. Pedagogia da autonomia: Saberes necessários à prática educativa. São Paulo: Paz e Terra; 1996.
- Freire P. Pedagogia dos oprimidos. 17. ed. Rio de Janeiro: Paz e Terra; 1984.
- Gomes ACFG, Furlan EK, Siqueira FRP. Adaptação de extensão universitária em engenharia durante pandemia: relato de experiência. In: Anais do XLIX Congresso Brasileiro de Educação em Engenharia e IV Simpósio Internacional de Educação em Engenharia. Brasília, DF: Abenge; 2021.
- Gomes L. Vídeos didáticos: uma proposta de critérios para análise. Rev Bras Estud Pedagog. 2008;89:477-92. <https://doi.org/10.24109/2176-6681.rbep.89i223.688>
- Gomes WOJ. O Instagram como ferramenta de divulgação científica, popularização e educação em solo [monography]. Goiânia: Universidade Federal de Goiás; 2021.
- Hill C. How often to post on social media. Chicago: Sproutsocial; 2022 [cited 2023 Oct 17]. Available from: <https://sproutsocial.com/insights/how-often-to-post-on-social-media/>.
- Instagram. Erosão do solo: Tipos e conceitos. GPPE-UFG; 2023a [cited 2023 Dec 21]. Available from: [instagram.com/reel/CrBrQp1ghXi/](https://www.instagram.com/reel/CrBrQp1ghXi/).
- Instagram. Erosão do solo: Causas e consequências. GPPE-UFG; 2023b [cited 2023 Dec 21]. Available from: [instagram.com/reel/CsUgxJ0gPtS/](https://www.instagram.com/reel/CsUgxJ0gPtS/).
- Instagram. Erosão do solo: Diagnóstico. GPPE-UFG; 2023c [cited 2023 Dec 21]. Available from: [instagram.com/reel/CrOxj6GAn8E/](https://www.instagram.com/reel/CrOxj6GAn8E/).
- Instagram. Erosão do solo: Prevenção e controle. GPPE-UFG; 2023d [cited 2023 Dec 21]. Available from: [instagram.com/reel/CrYWhGKgp7w/](https://www.instagram.com/reel/CrYWhGKgp7w/).
- Instagram. Shedding more light on how Instagram works; 2021 [cited 2023 May 30]. Available from: <https://about.instagram.com/blog/announcements/shedding-more-light-on-how-instagram-works>.
- Instagram. Understand how Instagram algorithms work and how they impact rankings; 2023e [cited 2023 May 30]. Available from: <https://creators.instagram.com/grow/algorithms-and-ranking>.

- Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira - INEP. Sinopses estatísticas da educação superior – Graduação. Brasília, DF: Ministério da Educação; 2022 [cited 2023 Oct 9]. Available from: <https://www.gov.br/inep/pt-br/aceso-a-informacao/dados-abertos/sinopses-estatisticas/educacao-superior-graduacao>.
- Jesus AS, Carvalho JC. Processos erosivos em área urbana e as implicações na qualidade de vida. *Bol Goiano Geogr.* 2017;37:1-17. <https://doi.org/10.5216/bgg.v37i1.46239>
- Jesus OSF, Mendonça T, Araújo ICL, Cantelli KB, Lima MR. O vídeo didático “Conhecendo o Solo” e a contribuição desse recurso audiovisual no processo de aprendizagem no ensino fundamental. *Rev Bras Cienc Solo.* 2013;37:548-53. <https://doi.org/10.1590/s0100-06832013000200025>
- Keutelian M. Best times to post on Instagram in 2023. Chicago: Sproutsocial; 2023 [cited 2023 Oct 17]. Available from: <https://sproutsocial.com/insights/best-times-to-post-on-instagram/>.
- Koehler AD, Nascimento GS. Tradução audiovisual no contexto do IFES - Possibilidades acessíveis na produção de vídeos didáticos. In: Machado SG, Lorete EO, editors. *Educação Inclusiva: Múltiplas práticas e olhares*. Venda Nova do Imigrante: Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo; 2019. p. 328-40.
- Leka AR, Grinkraut ML. A utilização das redes sociais na educação superior. *Rev Primus Vitam.* 2014;7:1-12.
- Lévy P. *Cybercultura*. São Paulo: Editora 34 Ltda.; 2010.
- Lima JA, Costa WP, Alexandre ES, Pinto FDL, Bões JS, Sampaio BHB. O impacto das redes sociais no processo de ensino-aprendizagem: Um estudo de caso sobre a plataforma engenharia construtiva. In: *Anais do XLVII Congresso Brasileiro de Educação em Engenharia e II Simpósio Internacional de Educação em Engenharia*; 2019 set 17-20; Fortaleza, CE. Brasília, DF: Abenge; 2019.
- Lopes BF, Jesus AS. Erosão dos solos em Goiânia-GO sob o enfoque do jornal diário da manhã. In: *Anais do XVII Simpósio Brasileiro de Geografia Física Aplicada e I Congresso Nacional de Geografia Física*; 2017 Jul 01-02; Campinas, SP. Campinas: Instituto de Geociências - Unicamp; 2017. p. 4196-201. <https://doi.org/10.20396/sbgfa.v1i2017.2313>
- Luz MP, Coelho AT, Santos Jr RD, Schlieve MS, Soares RM, Silva JL. *Recomendações técnicas em bioengenharia: Instalação e manutenção de cobertura vegetal de taludes na UHE Batalha*. Goiânia: FURNAS; 2021.
- Macedo ES, Sandre LH. Mortes por deslizamentos no Brasil: 1988 a 2022. *Rev Bras Geol Eng Ambient.* 2022;12:110-7. <https://doi.org/10.29327/241867.12.1>
- Mascarenha MMA, Carvalho JC, Jesus AS, Rezende LR, Sales MM, Luz MP. Interaction of geotechnics with society through education. *Soil Rocks.* 2024;47:e2024004023. <https://doi.org/10.28927/SR.2024.004023>
- Mascarenha MMA, Jesus AS, Guimarães MA, Kopp K, Oliveira AP, Sales MM, Angelin RR, Carvalho JC. Popularização do conhecimento em solos: Experiência de ação de extensão universitária junto à sociedade e comunidade escolar. In: *Anais do XIX Cobramseg*; 2018 Aug 28 - Set 01; Salvador, Brasil. São Paulo: ABMS; 2018.
- Mascarenha MMA, Rezende LRD, Jesus AS, Carvalho JC, Sales MM. Solos: Educação em sentido amplo. In: *Anais do X Simpósio Brasileiro de Educação em Solos*; 2021 Mar 02-05; Juazeiro, Brasil. Viçosa, MG: SBCS; 2021.
- Mendes TA, Pereira SAS, Rebolledo JFR, Gitirana Jr GFN, Melo MTS, Luz MP. Development of a rainfall and runoff simulator for performing hydrological and geotechnical tests. *Sustainability.* 2021;13:3060. <https://doi.org/10.3390/su13063060>
- Mendonça BA, Becker LB. The use of a video and a small-scale model for rain-induced landslides in geotechnical engineering education. *Soil Rocks.* 2024;47:e202400662. <https://doi.org/10.28927/SR.2024.006623>
- Morin E. *Os sete saberes necessários à educação do futuro*. São Paulo: Cortez Editora; 2014.
- Muggler CC, Pinto Sobrinho FA, Machado VA. Educação em solos: Princípios, teoria e métodos. *Rev Bras Cienc Solo.* 2006;30:733-40. <https://doi.org/10.1590/s0100-06832006000400014>

- Muggler CC, Vezzani FM, Lima MR, Silva V. Iniciativas de educação em solos no Brasil. Viçosa, MG: Sociedade Brasileira de Ciência do Solo; 2020.
- Oliveira VN, Gitirana Jr GFN, Mascarenha MMA, Sales MM, Varrone LFR, Luz MP. An enhanced flume testing procedure for the study of rill erosion. *Water*. 2021;13:2956. <https://doi.org/10.3390/w13212956>
- Passos AMA, Alvarenga RC, Santos FC. Direct planting system. In: Nobre MM, Oliveira IR, editors. *Agricultura de baixo carbono: Tecnologias e estratégias de implantação*. Brasília, DF: Embrapa; 2018. p. 61-104.
- Pennock D. *Soil erosion: the greatest challenge to sustainable soil management*. Rome: Food and Agriculture Organization of the United Nations; 2019.
- Resende LR, Vidal MJM, Melo KP, Curado TS. Uso do Instagram como ação de extensão para divulgação de conteúdo técnico-científico na engenharia civil. In: *Anais do 51º Congresso Brasileiro de Educação em Engenharia e VI Simpósio Internacional de Educação em Engenharia*; 2023 Set 18-20; Rio de Janeiro, RJ. Brasília, DF: Abenge; 2023.
- Schliewe MS, Menezes AV, Marques TA, Mascarenha MMA, Vasco JRG, Luz MP, Sales MM. Experimental study of erosion by waves on the lakeshore of lateritic soils. *J Hydrol*. 2021;603:127004. <https://doi.org/10.1016/j.jhydrol.2021.127004>
- Silva MCC, Carneiro RS, Rodrigues Filho LG, Barroso NMC. Uso de plataformas digitais para a divulgação de projeto de incentivo à leitura nos cursos de engenharia: O caso do LER - UFC. In: *Anais do XLVII Congresso Brasileiro de Educação em Engenharia e II Simpósio Internacional de Educação em Engenharia*; 2019 Set 17-20; Fortaleza, CE. Brasília, DF: Abenge; 2019.
- YouTube. Soil Science Society of America channel; 2023 [cited 2023 Dec 21]. Available from: <https://www.youtube.com/channel/UCcEbCxaahphQg7Cm-W849Rw>.